VIRTUAL REALITY
A CHALLENGE TO IMPROVE TRAINING ON TUNNEL SAFETY

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SiTI and Politecnico di Torino are research bodies and not tunnel safety operators

Politecnico di Torino (Turin Technical University) is a leading public research university, in Italy and in Europe, and has developed years of expertise in the fields of fire and safety.

SiTI is a non-profit association set up in 2002 between the Politecnico di Torino and the Compagnia di San Paolo, to carry out research and training oriented towards innovation. SiTI is a hinge between research results and stakeholders’ needs.

SiTI and Politecnico di Torino have been working in the field of Virtual Reality (VR) for years and envisage a great potential of VR-based training to improve the safety levels of tunnels.
TUNNEL EMERGENCY TRAINING

ROAD TUNNEL

- CONFINED SPACE
- LACK OF DAY LIGHT
- MAJOR LIMITATION FOR RESCUE AND EVACUATION

THREATS

- FIRE
- SMOKE
- HEAT
- VARIABLE AMBIENT CONDITIONS
- END-USERS’ BEHAVIOUR
- NATURE OF TRANSPORTED GOODS (FLAMMABLES, TOXIC SUBSTANCES, EXPLOSIVES)
- CONSEQUENCES OF COLLISIONS BETWEEN VEHICLES
- QUEUING (TRAFFIC)

COMPLEXITY

UNUSUAL DECISIONS IN CONDITIONS OF TIME PRESSURE, PANIC AND STRESS
TUNNEL EMERGENCY TRAINING

COMPLEXITY

UNUSUAL DECISIONS IN CONDITIONS OF TIME PRESSURE, PANIC AND STRESS

COMPLEX PROCEDURES AND PROTOCOLS FOR THE MANAGEMENT OF EMERGENCY

PERIODIC REAL SCALE EXERCISES

TRAINING IS REQUIRED BY INTERNATIONAL STANDARDS

2004/54/EC DIRECTIVE
TRAINING IS REQUIRED BY INTERNATIONAL STANDARDS

TRAINING IS A KEY SUCCESS FACTOR

END USERS
- INDIVIDUAL PRIVATE CAR DRIVERS
- PROFESSIONAL DRIVERS (TRUCK, BUSES)
- MAINTENANCE AND OPERATION STAFF

EMERGENCY OPERATORS
TRAINING: A KEY SUCCESS FACTOR

KEY PLAYERS OF EXERCISES
- TUNNEL OPERATORS
- FIRE AND RESCUE SERVICES
- TUNNEL SAFETY OFFICER
- POLICE
- AMBULANCE SERVICES

KEY ISSUES
- COMMAND AND CONTROL
- COMMUNICATIONS
- PERFORMANCE OF TUNNEL SAFETY EQUIPMENTS
- OPERATOR’S ACTIONS
- SAFETY

KEY ROLES
- CONTROLLER (WITH AUTHORITY TO OVERSIGHT AND ALTER PLANNED PROGRAM)
- DIRECTOR (COMPLIANCE WITH EXERCISE PROGRAMME)
- OBSERVER (ASSESSMENT AND WITNESSING )
- REFEREE (MEASUREMENT WHETHER ACTIVITY HAPPEN)
- OPERATORS
TRADITIONAL TRAINING TROUBLES

Many different operators involved to design and manage the exercise

High costs and long time to organize the events

Vehicles, tools, devices, people must be made available for the entire duration of the event

Hard to assimilate and low grade of repeatability

Engagement of different infrastructures (e.g. ICT) that cannot operate at their full potential during the event

Geographical Barriers: people and units far from one another may be difficult to involve simultaneously
Virtual Reality (VR)
an innovative tool to help solve traditional training troubles

VR is an artificial, computer-generated replication of a real life environment or situation. It immerses the users by making them feel like they are experiencing the simulated reality firsthand, primarily by stimulating their vision and hearing.

Immersion is a term used to describe the sensation of being inside a particular environment, e.g. a 3D world.

The aim is for the users to become unaware of their surroundings to the extent that they assume a new identity or interact in innovative, enjoyable and exciting ways.

In a simulation everything is possible. It’s possible to recreate realistic environments, e.g. any tunnel safety scenarios.
A serious game or applied game is a game designed for a primary purpose other than pure entertainment. The "serious" adjective is generally prepended to refer to video games used by industries like defense, education, scientific exploration, health care, emergency management, city planning, engineering, and politics.
VR today *(serious games)*

**LEARN MORE WITH LESS**

### Time
- Faster organisation
- Faster design of exercises
- Repeatability and more efficient learning

### Costs
- No travel is required
- No resources (gasoline, vehicles, hotels)
- No engagement of infrastructures
- No overtime
- No insurances

### Efficiency
- Environments can be customized
- Training can be customized
- Shocking realistic experiences (not «just paperwork»)
- Easy Repeatability
- Flexibility (scenarios can be easily changed)
Security and Safety
- Trainers are not affected by real fire, chemical substances, smoke, etc.
- Operational Infrastructures and services are not affected.
- Reduction of operations’ stress by making them “live” challenging situation, psychophysical preparing them to real danger.

Monitoring
- Trainees are continuously under control
- Real-time adjustment of scenarios
- Mistakes are reported
- Automatic logging of all operations and decisions
- Better debriefing, post-incident analysis and Feedback,
- Reporting and compliance check of exercise checklist
- Score board

Geographical Barriers
- Remote interactions also among operators from different countries or in locations scattered over a wide area
VIRTUAL REALITY IN THE FUTURE

**TODAY “2018”**
TRAINING EXERCISES IN **COMPLIANCE WITH PROCEDURES AND PROTOCOLS (CCP)**

**TOMORROW “2020/21”**
CCP TRAINING EXERCISES + SIMULATED FIRE AND SMOKE PROPAGATION (THIS IS THE CORE OF POLITO’S RESEARCH)

“PHENOMENOLOGICAL” APPROACH
DETAILED REALISTIC SIMULATION OF FLUID DYNAMIC PROCESSES

VISIT OUR STAND!
VIRTUAL REALITY **tomorrow**

**“PHENOMENOLOGICAL” APPROACH**

DETAILED REALISTIC SIMULATION OF FLUID DYNAMIC PROCESSES

- PROVIDES INFORMATION ABOUT
  - CLIMATIC CONDITIONS
  - DISTRIBUTION OF GASES AND TOXIC SUBSTANCES
  - AIR VELOCITY

- TALKING INTO ACCOUNT
  - TRAFFIC (determining variables space profiles of indoor environment)
  - VENTILATION SYSTEM
  - FIRE FIGHTING ACTIVES

- INTEGRATION OF FIRE AND SMOKE DYNAMIC DATA WITHIN VR PLATFORM

- FIRE SPREADING IN REALISTIC WAY, INCLUDING 3D VISUALIZATION OF TOXIC GASES AND HAZARD LEVELS

- SIMULATION OF ACTIONS BY EMERGENCY OPERATORS (e.g. fire extinguishing)
VIRTUAL REALITY tomorrow
Examples of Simulation Tools for VR

Compact modelling techniques are necessary in order to make the analysis and optimization of these systems possible and accurate in a reasonable time. The multi-scale approach is hybrid 1D-3D computational techniques based on non-overlapping domain decomposition. It consists in the splitting of the full domain in sub-regions assigning to each one a model of different complexity, i.e. 1D and 3D.
Project on **VR Training for Risk**

2018 - 2021, budget 2M€
Resilience, Information, Sensitization and communication

*Primary objective*
Training for operators and citizens using Virtual Reality
*(will start in a few weeks)*

- Shared network of VR facilities and laboratories
- Training scenarios
- VR tools to train Fire Brigades, SDIS and Civil Protection
- VR tools to train Volunteers and Citizens
- Focus on fire, earthquakes and floods
- Serious gaming to train operators on protocols
- Phenomenological approach for fire and smoke
- Complete exercise simulation
VIRTUAL REALITY *tomorrow*

**ICT - SOME EVOLUTIONARY ISSUES**

**Multi-actor simulation**, letting diverse users play different roles (citizens, infrastructure operators, emergency staff, etc.) in a distributed scenario involving hubs/clients nodes with heterogenous characteristics.

**Control room** for managing – before or during the VR experience – key parameters of the simulation, in order to vary and tailor it as needed (e.g., based on learning objectives, learners’ skills) as well as to foster/maintain engagement.

**VR setups with body/head/hand tracking capabilities** (consumer-grade or projection-used professional-grade systems) and in passive modality (for communication/prevention applications).
VIRTUAL REALITY *tomorrow*

ICT - SOME EVOLUTIONARY ISSUES

Integration in the scenarios of **information from external simulation systems** (e.g., concerning fire and smoke propagation) → *phenomenological* approach

Use of **AI-powered Non-Playing Characters** (NPCs) to increase the realism of the simulation (e.g., vehicles, crowds, panic situations, etc.)

Manage **multiple human-machine interaction paradigms** to boost naturalness of the experience (collaboration, voice and gestures, haptic feedback to simulate heat, etc.)

*long term*
What you will see in our stand

VR Fréjus demo

(EMERGENCY OPERATORS)

VR Fréjus demo

(END USERS)

VR Training for Civil Protection

www.pro-prodige.eu

CBRN Training demo
Thank you for your attention

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